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PATENT APPLICATION TRANSMITTAL LETTER

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Transmitted herewith for filing is the patent application of

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For: **SYSTEM AND METHOD FOR HANDLING FLOWS IN A NETWORK**

Enclosed are:

1. 7 sheets of specification, 5 sheet of claims, 1 sheet of abstract; and 4 sheets of drawings (Figs. 1-4);

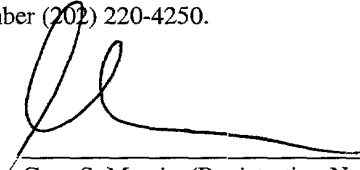
The filing fee has been calculated as shown below:

	NUMBER FILED	NUMBER EXTRA*	RATE (\$)	FEE (\$)
BASIC FEE			690.00	690.00
TOTAL CLAIMS	29 - 20 =	9	18.00	162.00
INDEPENDENT CLAIMS	3 - 3 =	0	78.00	0.00
MULTIPLE DEPENDENT CLAIMS PRESENT				0.00
FEE FOR RECORDATION OF ASSIGNMENT			00.00	00.00
*Number extra must be zero or larger			TOTAL	\$852.00

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5. The Office is authorized to charge the filing fee of **\$852.00** to Deposit Account No. **11-0600**. A duplicate copy of this paper is enclosed for that purpose.
6. Please direct all correspondence to Gary S. Morris, Kenyon & Kenyon, Suite 700, 1500 K Street, NW, Washington, D.C. 20005, Telephone Number (202) 220-4250.

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SYSTEM AND METHOD FOR HANDLING FLOWS IN A NETWORK

Claim to Priority

This application claims the benefit of United States Provisional Application No. 60/149,174, filed on August 17, 1999.

Field of the Invention

The field of the invention is handling flows in a network, and in particular handling packets that relate to the same conversation as a part of a flow.

Brief Description of the Drawings

Figure 1 shows a switch that handles a flow between two hosts in accordance with an embodiment of the present invention.

Figure 2 shows a flow that passes through one Ethernet switch between two hosts in accordance with an embodiment of the present invention.

Figure 3 shows flows between two switches and two hosts in accordance with an embodiment of the present invention.

Figure 4 shows multicast flows in accordance with an embodiment of the present invention.

Summary of the Invention

A flow in a network is identified and handled by using a virtual host address. A packet is received at a switch with a first virtual host address as its destination address. If the packet is the first packet of a flow received by the switch, then a second virtual host address is determined by the switch. The first virtual host address is stored in a packet forwarding table correlated with the second virtual host address. A subsequently received packet of the same flow has the same first virtual host address as its destination address, and is forwarded to the second virtual host address in accordance with the packet forwarding table.

Detailed Description

The wide area network is evolving to one that integrates virtual circuit switching (label

The Ethernet frame format illustrated above consists of a destination address, source address and protocol type indicator followed by the payload and a frame check. In the following diagrams which describe how Ethernet addresses are manipulated during switching, we are only interested in the destination and source addresses. So Ethernet packets will be represented thus:

DESTINATION	SOURCE	
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Certain Ethernet addresses are used to identify flows. This is done in such a way that network software in the host computers connected to the network work under the impression that the Ethernet, as always, is a device for sending datagrams (individual packets) from one computer to another. An Ethernet switch that supports flows behaves as if it contains within it one virtual host for every flow.

Figure 2 illustrates a flow that passes through one Ethernet switch between hosts H and K. The flow is represented in that switch by virtual host V. Host H is connected by an Ethernet to port P1 of switch S, and P2 is connected by Ethernet to host K. Within the switch, incoming packets with destination address V are routed according to the table shown in the lower block. Packets arriving with host address H are rejected if they did not come from port P1. Likewise, packets from K are rejected if they did not come from port P2.

The packet forwarding process first copies the destination address (V) of the incoming packet into the source address of the outgoing packet and then it copies the new destination address from the table. Host K is the destination for packets coming from H, and host H is the destination for packets coming from K.

The same procedure applies when switches are connected in tandem. Figure 3 illustrates the case when there are two switches between hosts H and K.

As is usual with Ethernet switches, the IP addresses and Ethernet addresses of hosts attached to a particular port are discovered by scanning packet source addresses or by using ARP.

The packet forwarding table used by each virtual host is constructed by examining the header of the first IP packet in a flow.

Of course, virtual hosts do not really exist, even as processes within a switch. It is just that the actions of a switch as seen from outside are exactly as described by the model. Internally the switch uses a combination of technologies found today in IP routers and virtual circuit switches. It is a table-driven process that stores packets in queues, processes their headers and transfers them to the appropriate output ports with appropriate attention to the quality of service appropriate to each traffic class.

The same technique can be used for point to multipoint flows, as shown in Figure 4. In this example, host H is the root of a multicast tree that transmits packets to the two hosts K and L. The forwarding table now has three rows, one for each host in the multicast, and a third column indicates which host is the “root” of the multicast tree. Packets coming from H are copied to each of the hosts given in the other rows of the table. Packets addressed to V from K and L may either be rejected or propagated upstream depending upon the permission stated in the “perm” column. Note that if K and L do transmit packets upstream, H must examine the IP header to determine the source of each packet.

An example of a virtual circuit signaling connection set-up protocol follows. A protocol for setting up a connection between two hosts A and B takes place in three stages. First A requests that the connection be made, then B accepts the request and causes a virtual circuit to be created, and finally A confirms that indeed there is a connection.

The connection request is sent as an ordinary IP datagram from A to B. The accept message is sent as a signal, which is a message from A to B that is flagged for special attention in each of the network nodes along the way. As this signal progresses through the network a (full duplex) virtual circuit is created between A and B. Finally, the confirmation message from A is transmitted over the new virtual circuit.

A socket number is an identifier chosen by a host to represent one end of a connection. Socket numbers for successive conversations should be different one from another so that a long time will elapse between repeated use of any one socket number. This allows any messages involved in a connection set-up to be retransmitted without ambiguity. For IPv4 the socket number is synonymous with port number as used by TCP or UDP. In other words, as is well known in art, a port number is associated with a socket number, and this association of a port number to a socket can change over time. See, for example, W.R.Stevens "Unix Network Programming", Prentice Hall Software Series, April 1990, Chapter 6, "Berkeley Sockets", pages, 258-304.

The connection, accept and confirm message are coincident with the IP packets which normally start a TCP virtual circuit connection on the Internet. A TCP session begins with the following 3-way handshake: Client host A chooses a port number and sends a SYN message to server host B. B chooses a port number, and sends a SYN message to A. A can then use the connection, and sends an ACK message to B. B then understands that it can also use the connection.

Implementation of the TCP virtual circuit as a switched flow at layer 2 takes place concurrently with step two of this handshake. No extra packets need be transmitted.

The embodiments described above advantageously protect the confidentiality, integrity and authenticity of a conversation represented by a flow. As used herein, protecting "confidentiality" means preventing unauthorized access to the contents of the flow. Protecting "integrity" means preventing the unauthorized manipulation or alteration of the flow. Protecting "authenticity" means providing some assurance that the purported source of a packet is the actual source of the packet. As shown in Figure 2, the VC forwarding table stores a list of allowed hosts (real and virtual) from which packets may come, and to which packets may be sent. Also, switch S stores the port number through which switch S communicates with each host. When a packet from H arrives at switch S through port P, switch S searches the VC forwarding table for a record that correlates the source address of the packet with the port number through which the packet has arrived. If such a record is not found in the VC forwarding table, then the packet is rejected.

What is claimed is:

1. A method for identifying a flow, including:
receiving a request from a host for a flow identifier;
sending a flow identifier to the host; and
receiving a packet with the flow identifier as the address.
2. The method of claim 1, wherein the address is a source address.
3. The method of claim 1, wherein the address is a destination address.
4. The method of claim 1, wherein the flow identifier is an address of a virtual host.
5. The method of claim 1, wherein the destination address of the packet is the address of a virtual host.
6. The method of claim 1, wherein the source address of the packet is the address of a virtual host.
7. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet payload, wherein the Ethernet header has an Ethernet source address and an Ethernet destination address, and wherein the flow identifier is a the Ethernet source address.
8. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet payload, wherein the Ethernet header has an Ethernet source address and an Ethernet destination address, and wherein the Ethernet source address is the address of a real host.
9. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet payload, wherein the Ethernet header has an Ethernet source address and an Ethernet destination address, and wherein the Ethernet source address is the address of a virtual host.

1 10. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet
2 payload, wherein the Ethernet header has an Ethernet source address and an Ethernet
3 destination address, and wherein the Ethernet destination address is the address of a real
4 host.

1 11. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet
2 payload, wherein the Ethernet header has an Ethernet source address and an Ethernet
3 destination address, and wherein the Ethernet destination address is the address of a
4 virtual host.

1 12. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet
2 payload, wherein the Ethernet header has an Ethernet source address and an Ethernet
3 destination address, and wherein the flow identifier is a the Ethernet source address.

1 13. The method of claim 1, wherein the packet has an Ethernet packet header and an Ethernet
2 payload, wherein the Ethernet header has an Ethernet source address and an Ethernet
3 destination address, and wherein the Ethernet destination address is a first host address.

1 14. The method of claim 13, wherein the Ethernet payload has an Internet Protocol header
2 and an Internet Protocol payload, wherein the Internet Protocol header has an Internet
3 Protocol source address and an Internet Protocol destination address, and further
4 including:

5 determining a second host address based upon the Internet Protocol destination
6 address in the Internet Protocol header; and

7 storing the second host address correlated with the first host address in a packet
8 forwarding table.

9
10 15. The method of claim 13, wherein the first host address is the address of a real host, and
11 the second host address is a virtual host address.

1 16. The method of claim 13, wherein the first host address is a virtual host address, and the
2 second host address is the address of a real host.

1 17. The method of claim 13, further including:

2 changing the Ethernet source address of the packet to be equal to the first host
3 address;

4 changing the Ethernet destination address of the packet to be equal to the second
5 host address; and

6 sending the packet.

1 18. The method of claim 13, wherein the Ethernet payload has an Internet Protocol header
2 and an Internet Protocol payload, wherein the Internet Protocol header has an Internet
3 Protocol source address and an Internet Protocol destination address, and further
4 including:

5 determining a second host address from a packet forwarding table;

6 changing the Ethernet source address of the packet to the first host address;

7 changing the Ethernet destination address of the packet to the second host address;

8 and

9 sending the packet.

1 19. The method of claim 1, wherein an incoming packet that has a first host address as its
2 destination address arrives at a port having a first port identifier, and wherein a packet
3 forwarding table correlates the first host address with a second port identifier; and further
4 including rejecting the packet if the first port identifier is not equal to the second port
5 identifier.

1 20. The method of claim 1, wherein the Ethernet payload has an Internet Protocol header and
2 an Internet Protocol payload, wherein the Internet Protocol header has an Internet
3 Protocol source address and an Internet Protocol destination address, and further
4 including:

1 determining a plurality of forwarding host addresses from a packet forwarding
2 table;
3 changing the Ethernet source address of the packet to the first host address;
4 creating a copy of the packet for each forwarding host address;
5 changing the Ethernet destination address of each copy of the packet to a
6 forwarding host address; and
7 sending each copy of the packet.

1 21. The method of claim 20, wherein a forwarding host address is the address of a real host.

1 22. The method of claim 20, wherein a forwarding host address is a virtual host address.

1 23. A method for handling flows, including:
2 adding a virtual circuit flag to a packet; and
3 setting the value of the virtual circuit flag to indicate when the packet belongs to a flow
4 and requests that the flow recognized by the network.

1 24. The method of claim 23, further including:
2 determining if the virtual circuit flag indicates a flow; and
3 if the virtual circuit flag indicates a flow, then replacing the an address of the packet with
4 a host address.

1 25. The method of claim 24, wherein the source address of the packet is replaced with a host
2 address.

1 26. The method of claim 24, wherein the destination address of the packet is replaced with a
2 host address.

1 27. The method of claim 24, wherein the host address is the address of a real host.

1 28. The method of claim 24, wherein the host address is a virtual host address.

Abstract of the Invention

A flow in a network is identified and handled by using a virtual host address. A packet is received at a switch with a first virtual host address as its destination address. If the packet is the first packet of a flow received by the switch, then a second virtual host address is determined by the switch. The first virtual host address is stored in a packet forwarding table correlated with the second virtual host address. A subsequently received packet of the same flow has the same first virtual host address as its destination address, and is forwarded to the second virtual host address in accordance with the packet forwarding table.

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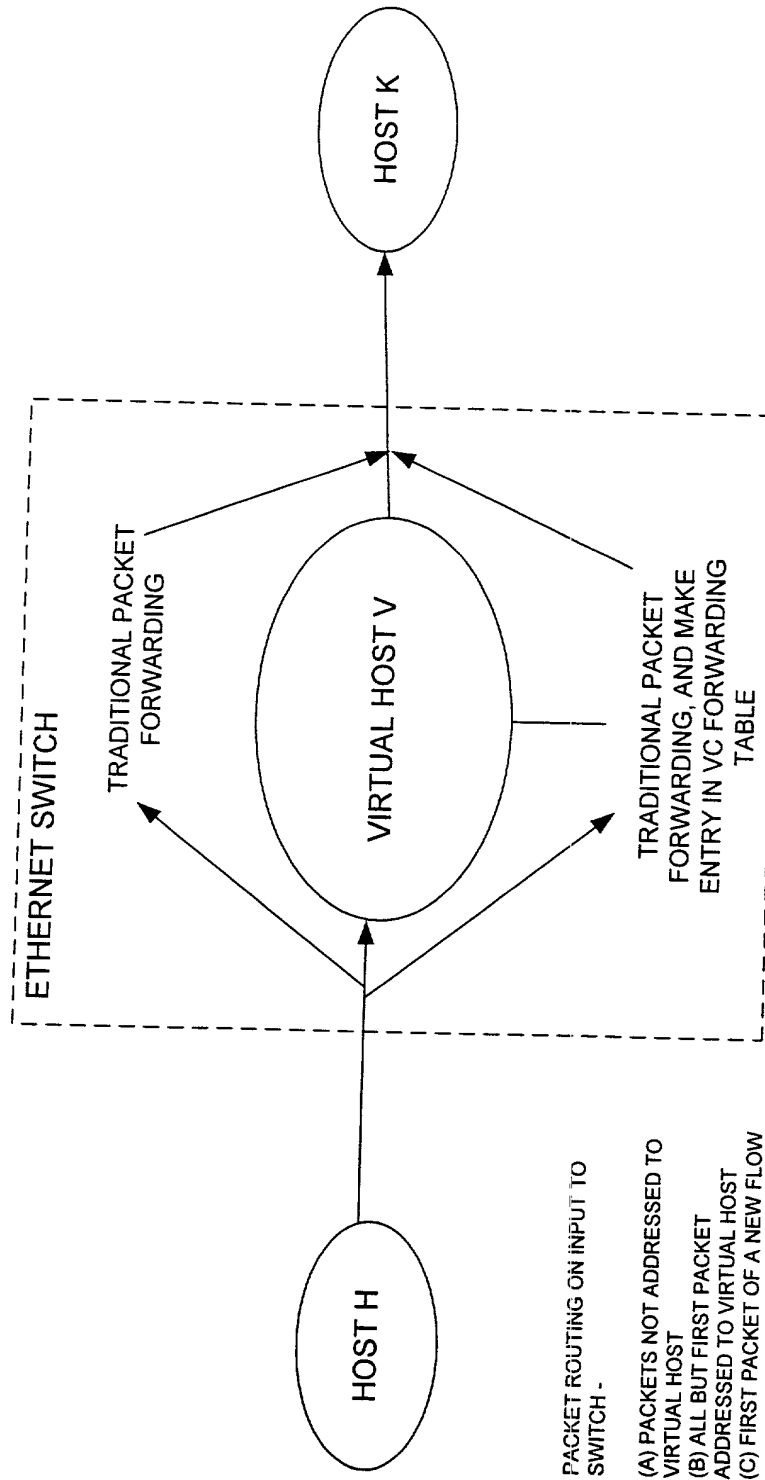
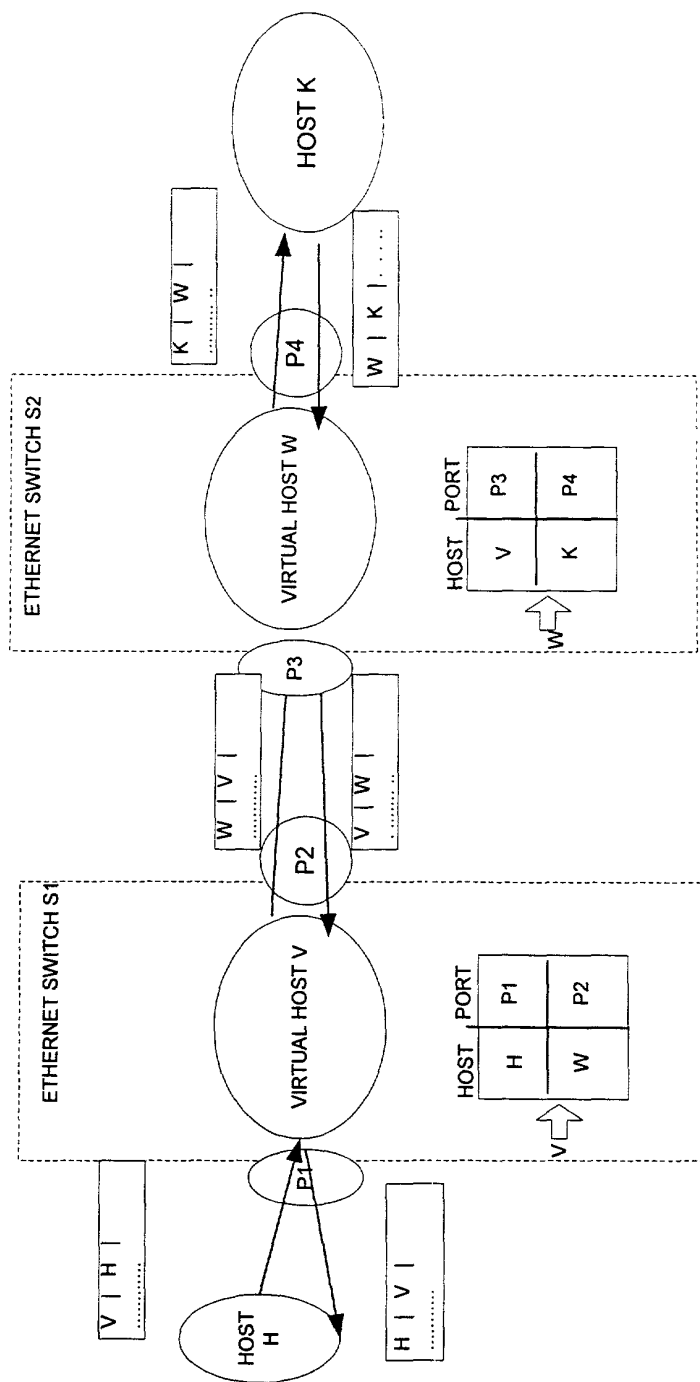


FIGURE 1
ETHERNET SWITCH
WITH FLOW SWITCHING

- PACKET ROUTING ON INPUT TO SWITCH -
- (A) PACKETS NOT ADDRESSED TO VIRTUAL HOST
 - (B) ALL BUT FIRST PACKET ADDRESSED TO VIRTUAL HOST
 - (C) FIRST PACKET OF A NEW FLOW

FIGURE 3



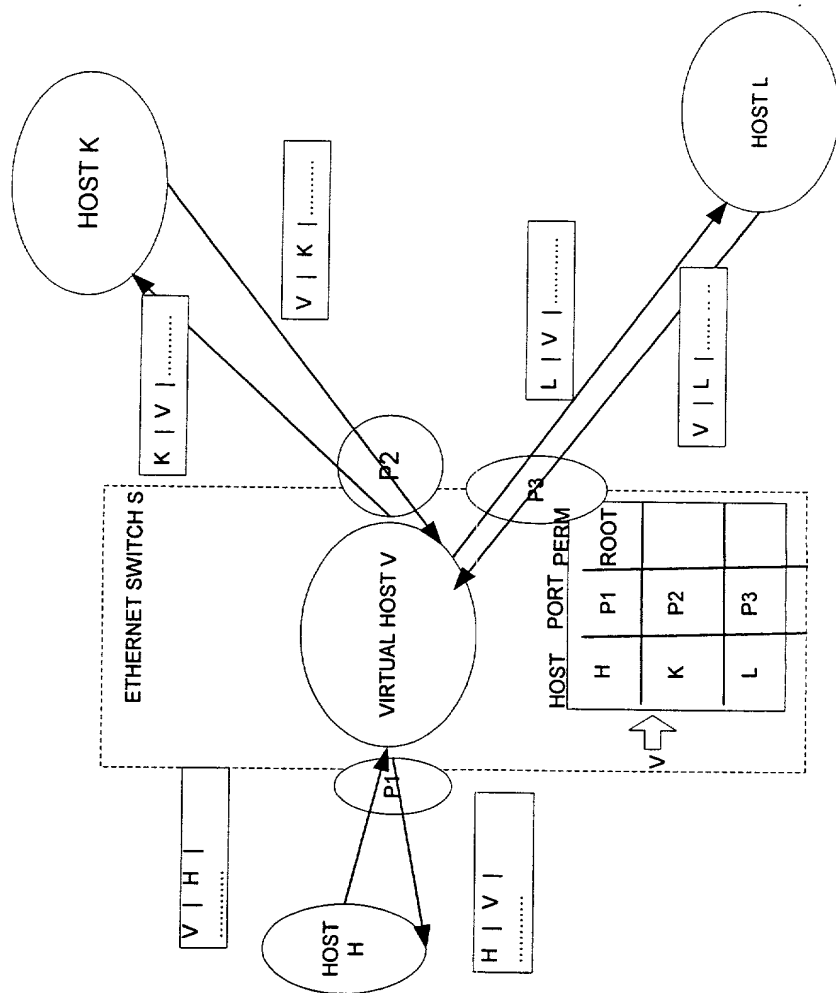


FIGURE 4